



Federal Office for  
Radiation Protection

# Phase II testing of Xenon International at RN33

**July 14<sup>th</sup>, 2021 to Jan 22<sup>nd</sup>, 2022**

Sofia Brander, Sandra Baur, Roman Kraiss, J. Ole Ross, TBE / PNNL\*, Andreas Bollhöfer

\* Aaron Orr, Ryan Sayne, Michael Howard, Michael Mayer, Mark Panisko, James C. Hayes

WOSMIP

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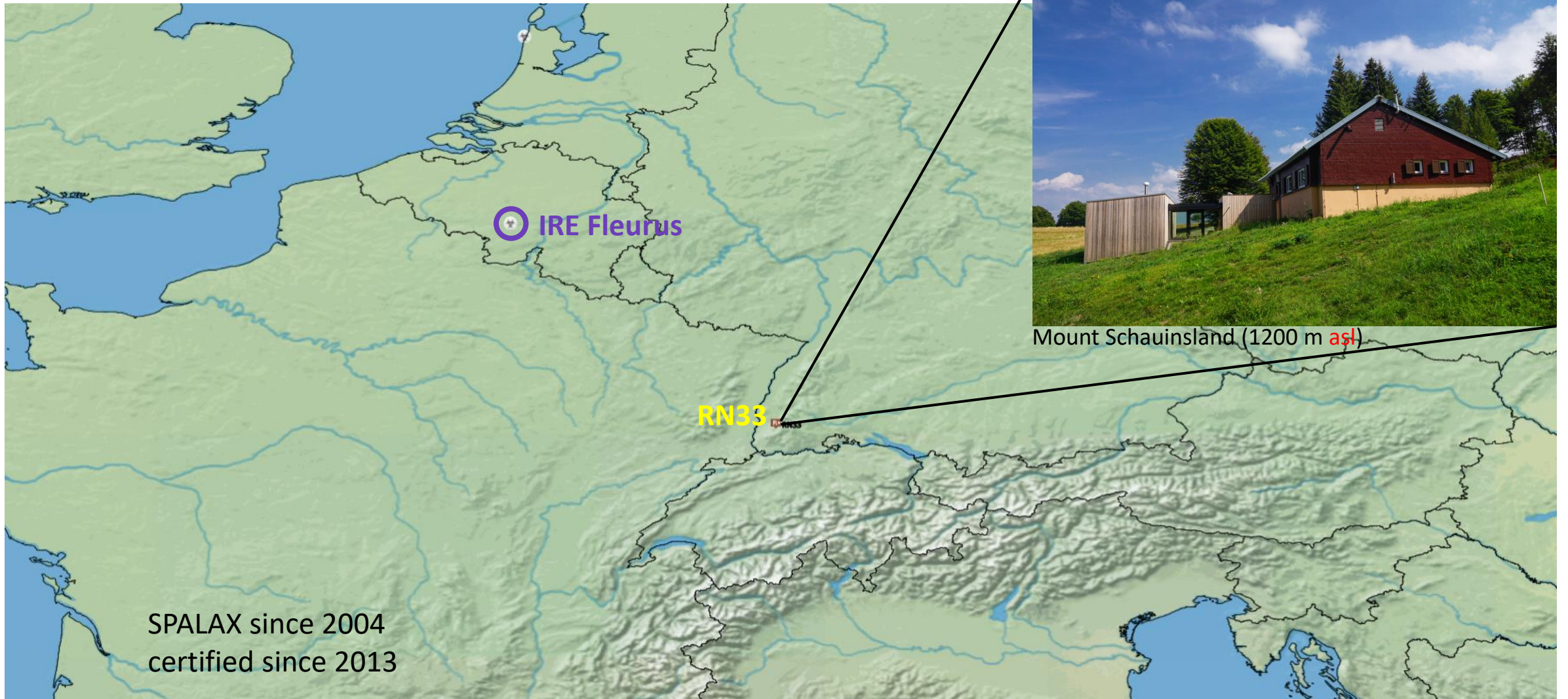




## Overview

- RN33 and Xenon International at RN33
- Xenon International
  - Phase II
  - Data analysis
- Results
  - Sample re-analysis
  - Detection histories
  - Remarkable detections

# RN33





## Xenon International Phase II

Phase II: July 14<sup>th</sup>, 2021 to Jan 22<sup>nd</sup>, 2022

Install: June 28<sup>th</sup>, 2021

Deinstall: April 27<sup>th</sup>, 2022

Second generation system for the International monitoring system

6 h sampling time

ca. 2.5 mL Xe per sample

$\beta\gamma$ -coincidence ( $^{131m}\text{Xe}$  /  $^{133}\text{Xe}$  /  $^{133m}\text{Xe}$  /  $^{135}\text{Xe}$ )



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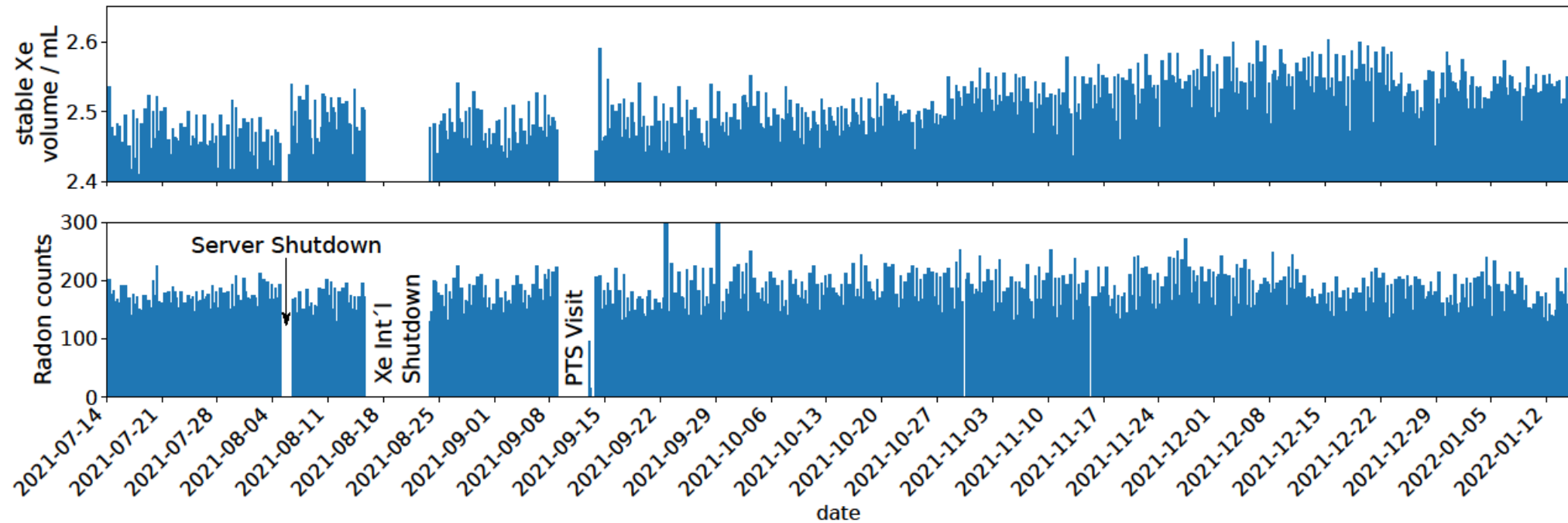
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# State of health and downtimes



- Aug 4<sup>th</sup> to 8<sup>th</sup>: mail server outage
- Aug 15<sup>th</sup> to 24<sup>th</sup>: heater failure in vacuum can

## Data analysis

CTBTO's Inspire 2.0.0

generally good agreement with PNNL's beta-gamma viewer software

Sample analysis: IMS lab or accredited (DIN EN ISO/IEC 17025) BFS Noble Gas Laboratory



**SAUNA - Lab**  
 **$\beta$ - $\gamma$  coincidence detection system**

MDA  $^{133}\text{Xe}$  (2 m<sup>3</sup> air, 24 h aq.):  
 $\approx 1$  mBq  
 $^{131\text{m}}\text{Xe} / ^{133}\text{Xe} / ^{133\text{m}}\text{Xe} / ^{135}\text{Xe}$   
Analysis of  $\beta\gamma$ -data with openSpex

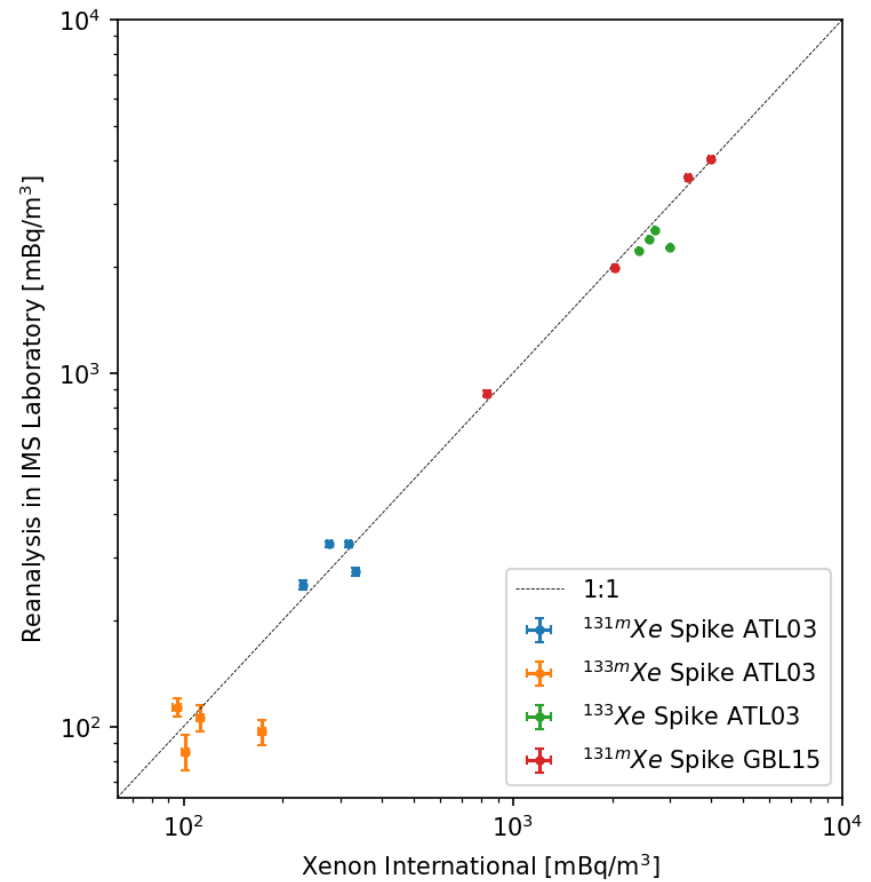
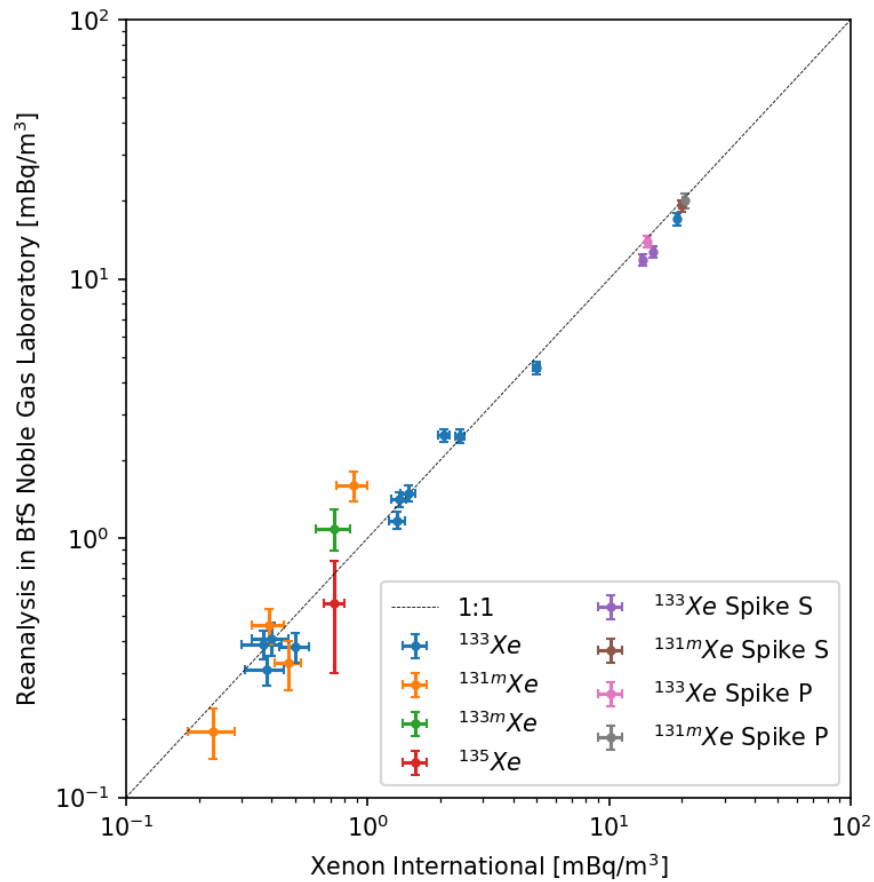


**Proportional counters**  
8 custom built **proportional gas counters**, Pb-shielding & anticoincidence counters

MDA  $^{133}\text{Xe}$  (2 m<sup>3</sup> air, 36 h aq.):  
 $\approx 8$  mBq  
 $^{131\text{m}}\text{Xe} / ^{133}\text{Xe}$  or  $^{133}\text{Xe} / ^{135}\text{Xe}$

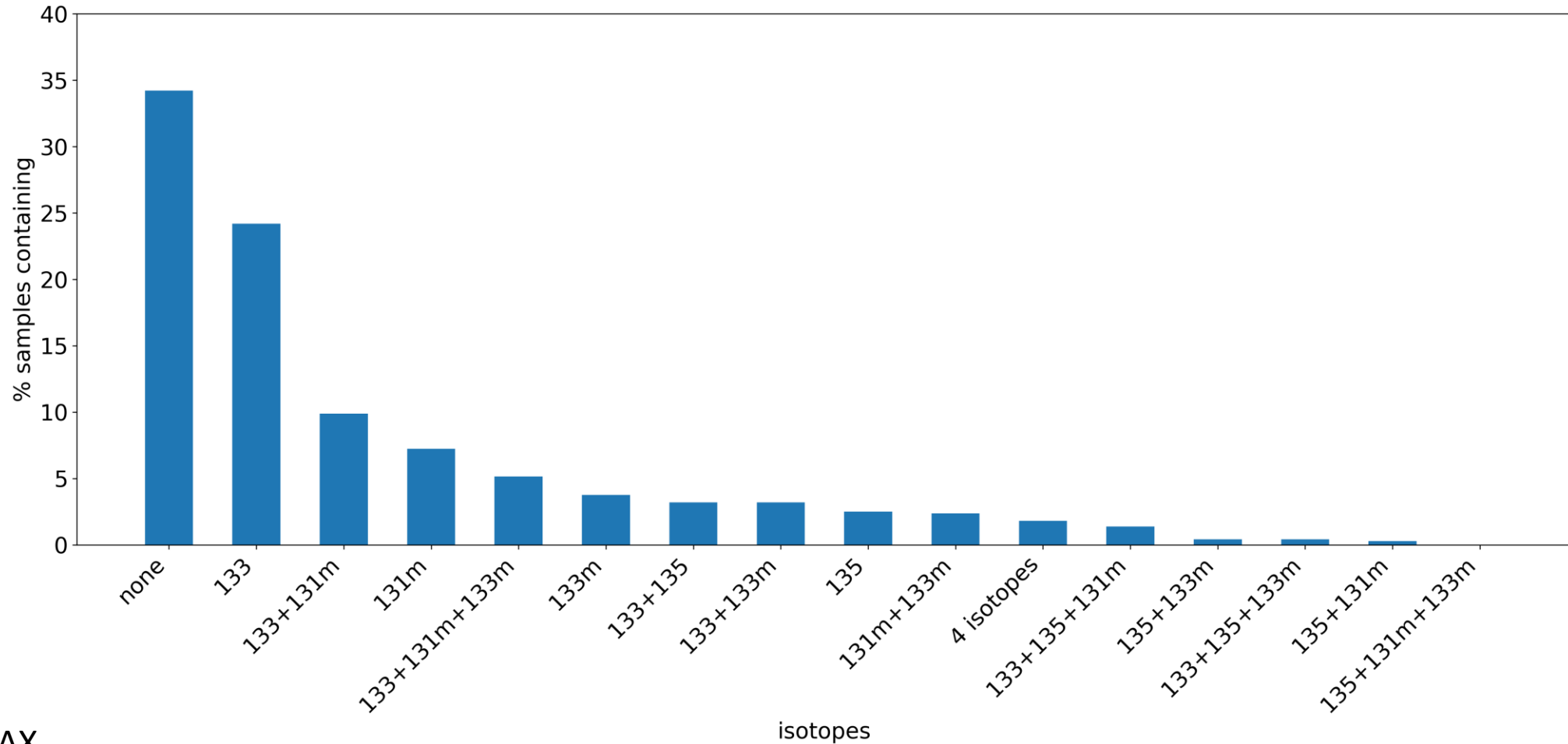
Isotope analysis via decay analysis

## Spike campaigns and environmental sample re-analysis



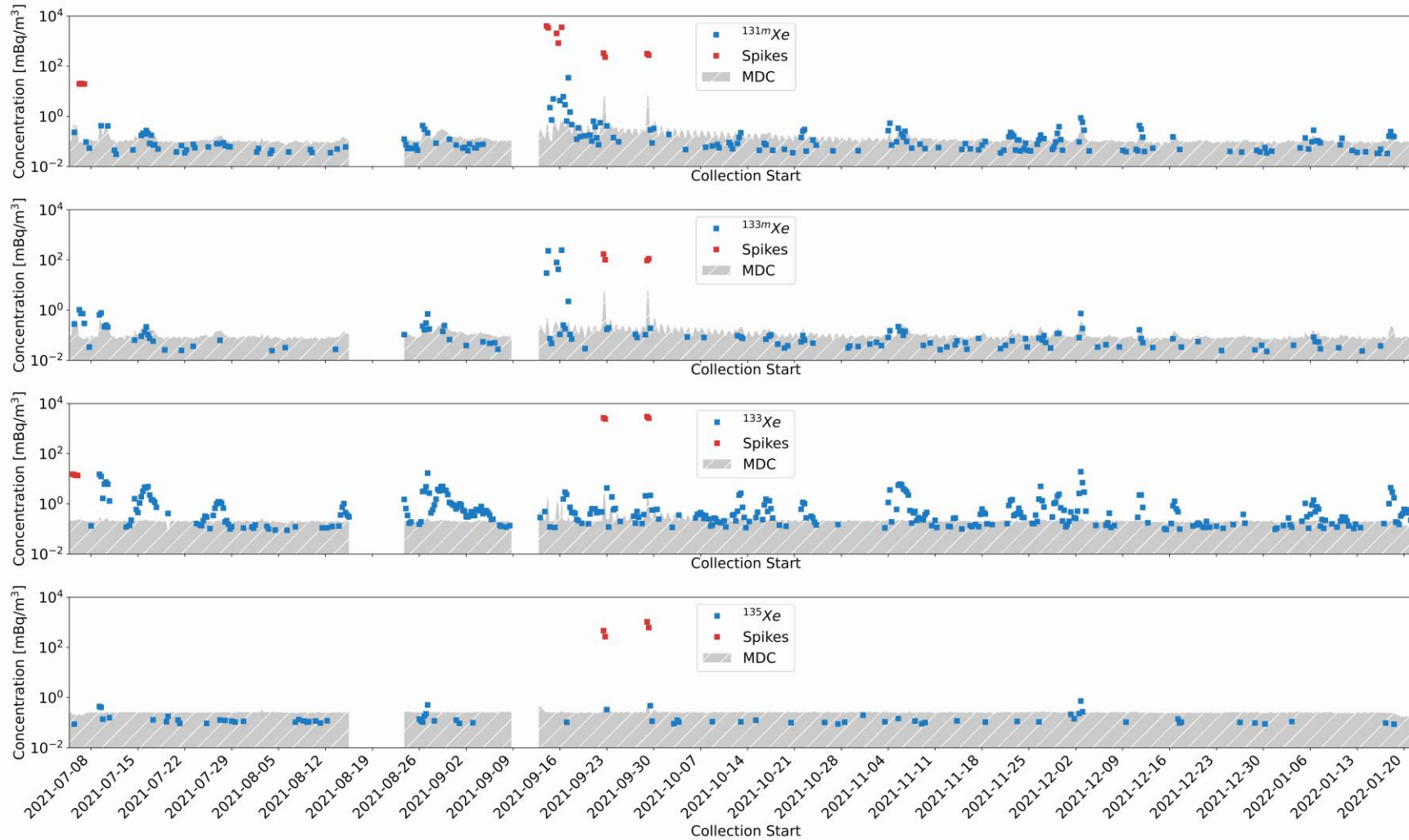


## Sample composition: % of samples containing nuclides (> LC):



SPALAX  
detections: 60% 40%

## Detection history of $^{131m}\text{Xe}$ , $^{133m}\text{Xe}$ , $^{133}\text{Xe}$ , and $^{135}\text{Xe}$



MDC:  
(0.163 ± 0.105) mBq/m<sup>3</sup>

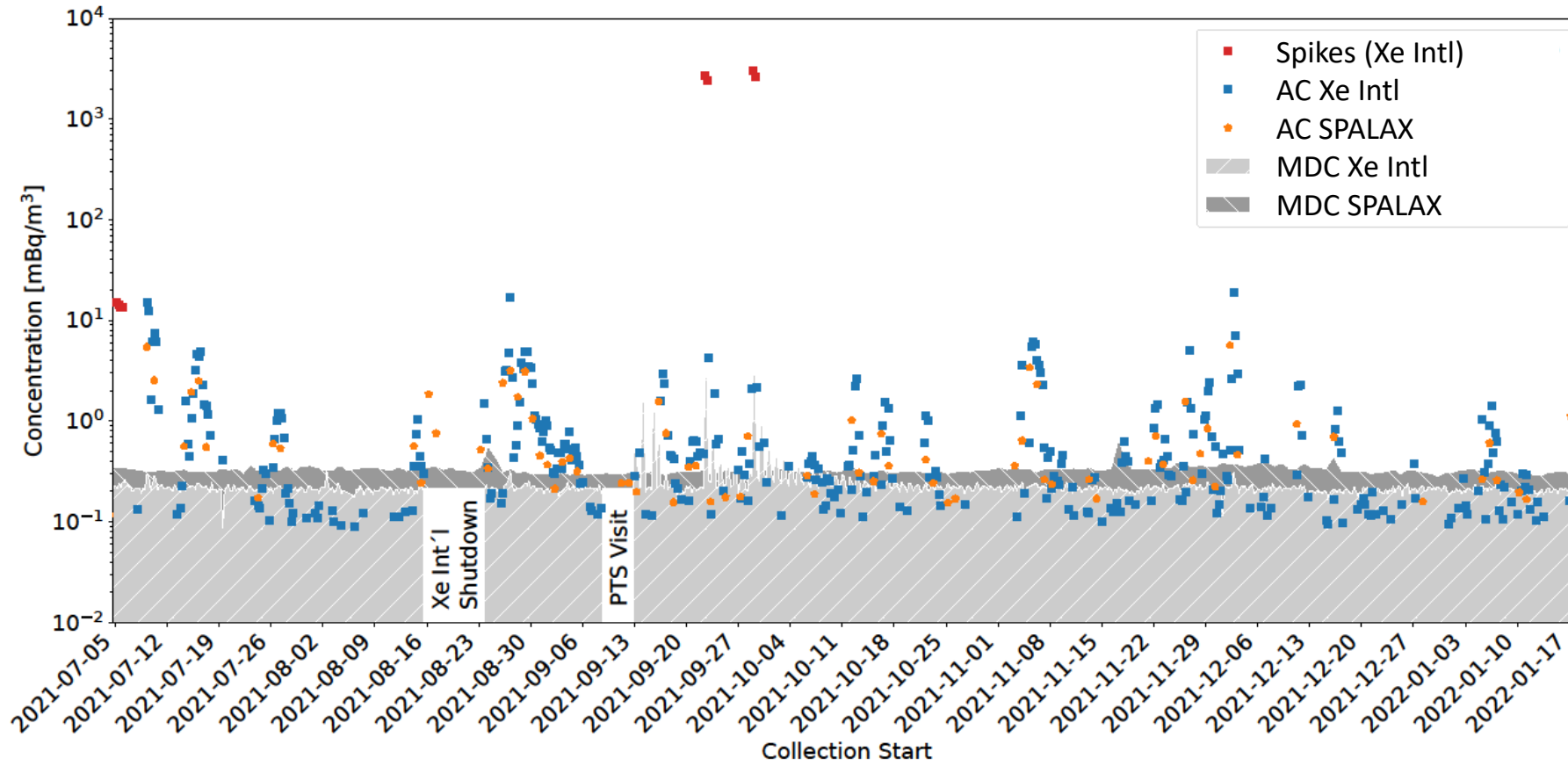
(0.126 ± 0.068) mBq/m<sup>3</sup>

(0.225 ± 0.060) mBq/m<sup>3</sup>

(0.268 ± 0.027) mBq/m<sup>3</sup>



## Detection history of $^{133}\text{Xe}$ – comparison with SPALAX



SPALAX MDC 0.33 mBq/m<sup>3</sup>  
sampling time: 24 h



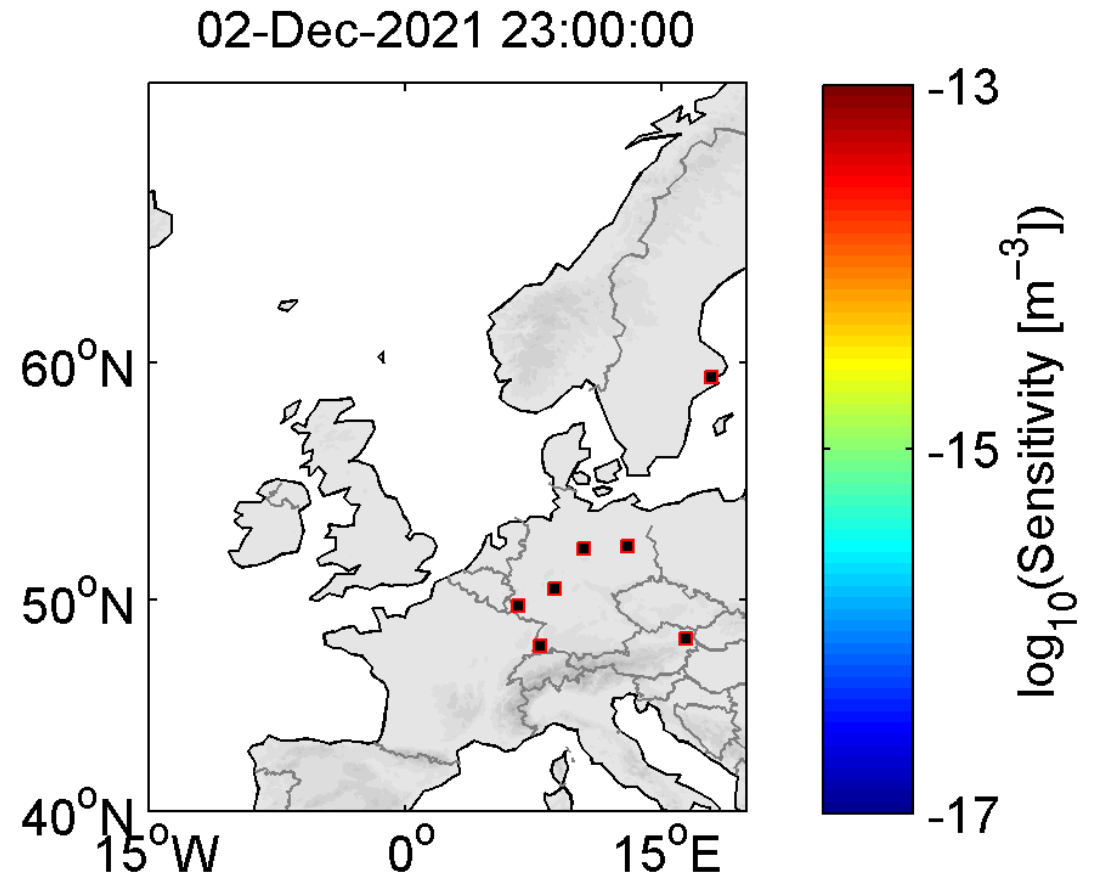
## Remarkable detections en detail - Dec 2nd 18:00 (UTC) – Dec 3rd, 2021, 00:00 (UTC)

$^{131m}\text{Xe}$ :  $(0.87 \pm 0.13) \text{ mBq/m}^3$   
 $^{133m}\text{Xe}$ :  $(0.73 \pm 0.12) \text{ mBq/m}^3$   
 $^{133}\text{Xe}$ :  $(19.1 \pm 0.29) \text{ mBq/m}^3$   
 $^{135}\text{Xe}$ :  $(0.73 \pm 0.07) \text{ mBq/m}^3$



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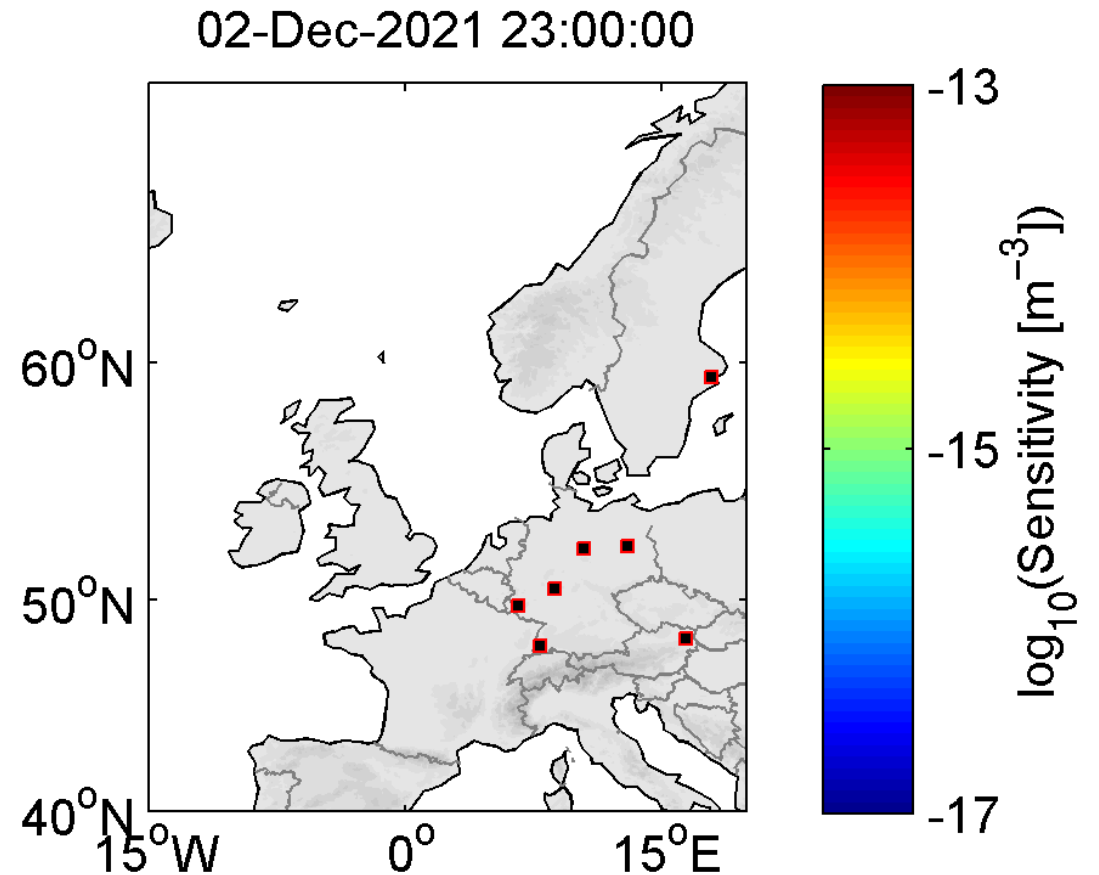


HYSPLIT, GFS 0.25°, 0.2° grid, 600.000 Particles

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- 4 isotope release at IRE Fleurus around 6:00 UTC
- normal transport time: (25-50) h. Here: (12-18)h  
→ winterstorm with  $v > 9 \text{ m/s}$  → explains presence of  $^{135}\text{Xe}$
- *Direct connectivity* → possible ATM „calibration“



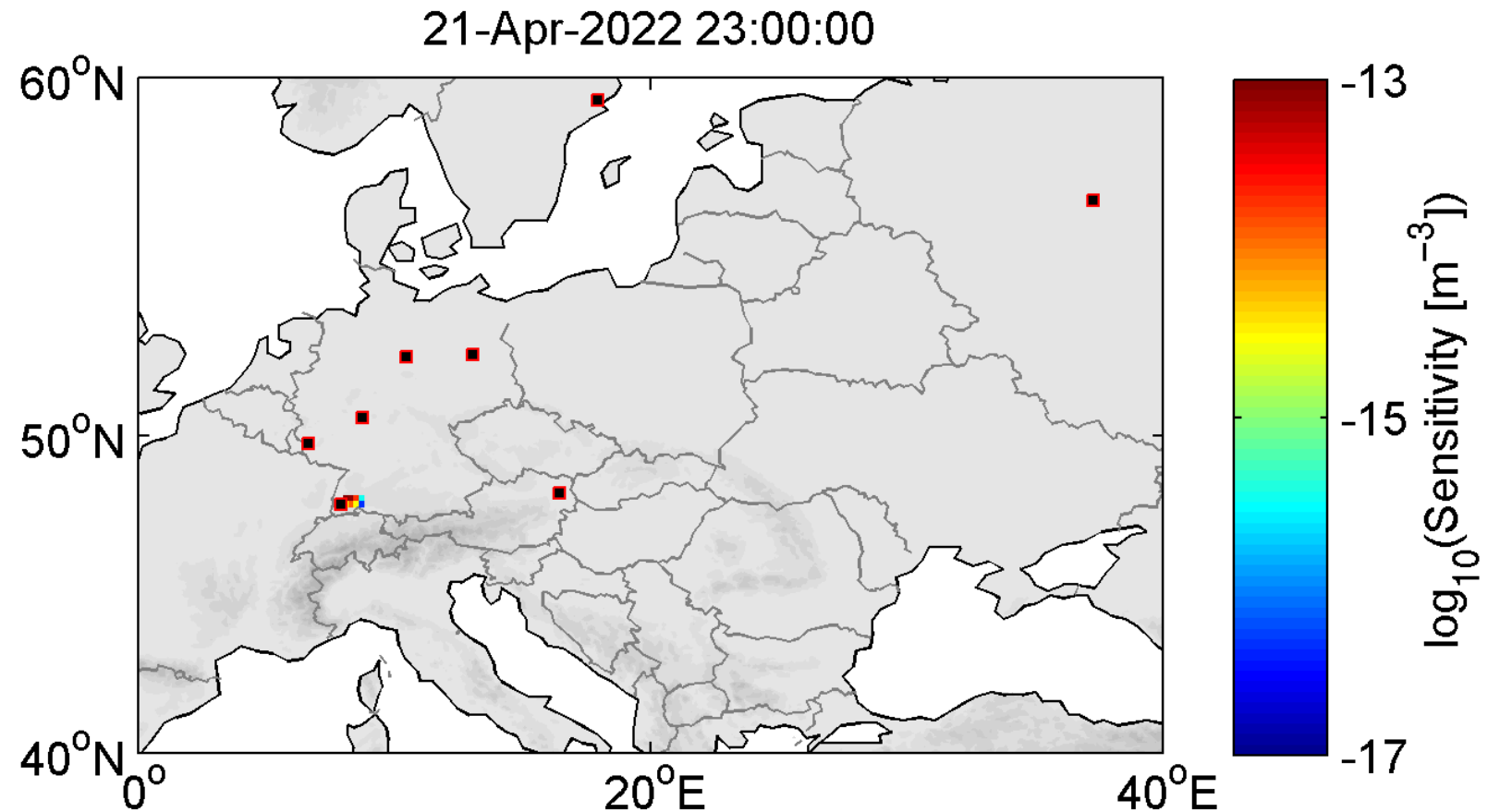


## Remarkable detections en detail: April 21st 18:00 (UTC) – 22nd 00:00 (UTC)

$^{131\text{m}}\text{Xe}$ : < LC  
 $^{133\text{m}}\text{Xe}$ :  $(0.90 \pm 0.17) \text{ mBq/m}^3$   
 $^{133}\text{Xe}$ :  $(37.8 \pm 0.9) \text{ mBq/m}^3$   
 $^{135}\text{Xe}$ :  $(0.43 \pm 0.06) \text{ mBq/m}^3$

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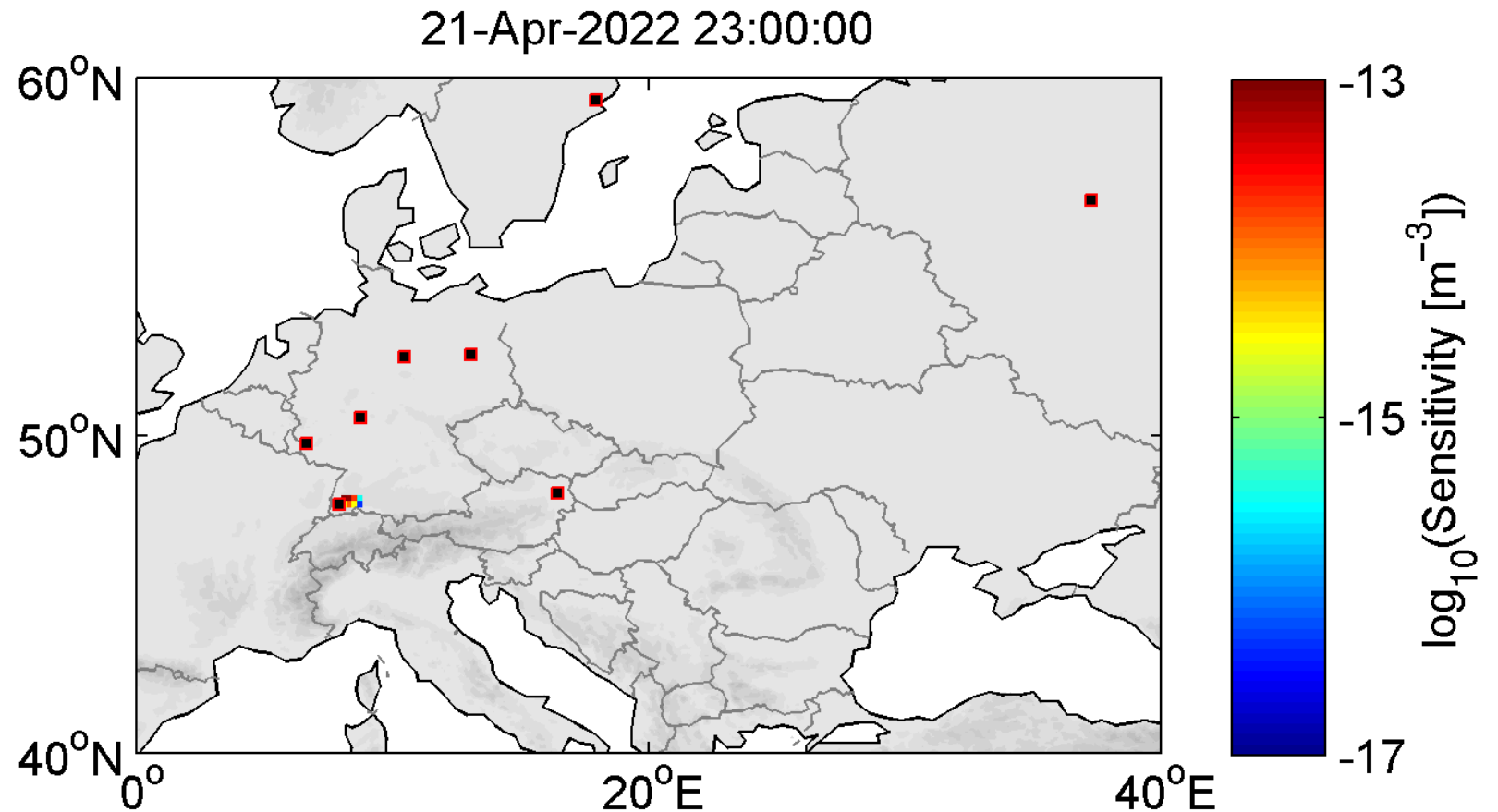


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Possible sources:

- ISAR 2
- Temelin
- Others?



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### Possible sources:

- ISAR 2 → no  $^{133}\text{Xe}$  in on-site monitoring
- Temelin → regular 2-month shutdown announced for April 14th, but no unusual release reported by operator
- Others?



## Conclusion and outlook

- Phase II testing was successful: July 14<sup>th</sup>, 2021 to Jan 22<sup>nd</sup>, 2022, with two outages
- Great agreement with laboratory results
- Several interesting detections
  - Dec 21: Direct connectivity to Fleurus
  - April 22: Undetermined source
- 6 h sampling time very helpful for localization → detailed ATM study to come
- Submitted: Sofia Brander, Sandra Baur, Roman Krais, J. Ole Ross, Aaron Orr, Ryan Sayne, Michael Howard, Michael Mayer, Mark Panisko, James C. Hayes and Andreas Bollhöfer: **Phase II Testing of Xenon International on Mount Schauinsland, Germany.** (*in review: WOSMIP special issue / Journal of Environmental Radioactivity*)



Federal Office for  
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#### Legal Notice

Bundesamt für Strahlenschutz  
Postfach 10 01 49  
38201 Salzgitter

Tel.: +49 30 18333-0  
Fax: +49 30 18333-1885  
E-Mail: [ePost@bfs.de](mailto:ePost@bfs.de)

[www.bfs.de](http://www.bfs.de)

#### Contact for questions

Sofia Brander  
[sbrander@bfs.de](mailto:sbrander@bfs.de)  
+49 30 18333 6745